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SEPARATION AND FREE FLIGHT TESTS OF 250-LB. MK [illegible] 500-LB. MK 82 LOW DRAG G. P. BOMBS WITH NOSE [illegible] RELEASED FROM A3D-1 AIRCRAFT

DEPARTMENT OF THE NAVY
BUREAU OF ORDNANCE

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

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Date: 27 MAY 1958

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U. S. Naval Proving Ground
Dahlgren, Virginia

Separation and Free Flight Tests of 250-lb Mk 81 and 500-lb Mk 82 Low Drag G.P. Bombs with Nose Fuze Plug Released from A3D-1 Aircraft

by

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Computation and Exterior Ballistics Laboratory

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ABSTRACT

Separation and free flight trajectory data were determined for the 250-lb Low Drag Bomb Mk 81 and 500-lb Low Drag Bomb Mk 82 with nose fuze plug released from A3D-1 aircraft (with 198-inch bomb bay) equipped with the Aero 7A ejector rack. On the basis of these data, the bombs were found to be unsuitable for service use with the A3D-1 aircraft equipped with the Aero 7A ejector rack (the same conclusion was reached for the bombs with AN/M103 nose fuze in an earlier report).

FOREWORD

This is the second partial report on separation and free flight tests of low drag bombs released from the A3D-1 aircraft equipped with the Aero 7A bomb ejector rack. The work, authorized by reference (a) was performed under Task Assignment NO 103-666/64042/01-059 and NO 230-666/64057/01-059. The tests are being conducted at the Naval Proving Ground under the direction of J. E. Mitchell, Computation and Exterior Ballistics Laboratory.

The Naval Air Test Center, Patuxent, Maryland, provided the services of the A3D-1 aircraft for use in the tests discussed in this report.

This report has been reviewed by:

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INTRODUCTION

An investigation of the effects on the ballistic performance of low drag bombs of the disturbed launching conditions which exist when these bombs are released from the A3D-1 aircraft is in progress at the Naval Proving Ground. Tests of the Mk 81 and Mk 82 low drag bombs equipped with AN/M103A1 mechanical Nose Fuze were reported in reference (b). Tests of the bombs equipped with nosc fuze plug are discussed herein; some additional data on the bombs equipped with the fuze are also contained in this report, and a summary of all drops of the Mk 81 and Mk 82 bombs made from the A3D aircraft is given. The program was interrupted at the conclusion of the drops reported herein because of temporary reassignment of the aircraft (drops of the Mk 83 bomb are scheduled; additional drops of the Mk 81 and Mk 82 bombs which were originally scheduled have been cancelled as a result of the conclusions given in this report).

DESCRIPTION OF MATERIAL

The 250-lb Mk 81 Mod 1 and 500-lb Mk 82 Mod 1 low drag general purpose bombs (see reference (c)) incorporate the general features of the Douglas Low Drag Shape when the nose fuze plug is used. (The nose fuze plug is designed for use with the electric fuzes now under development for the low drag bombs, when a mechanical nose fuze or a VT fuze is used, it replaces the nose fuze plug.) The fins of the bombs are nominally canted 2.0 degrees in the direction that will cause the bombs to spin clockwise as viewed from the rear. The bombs are equipped with two suspension lugs 14 inches apart and a hoisting lug midway between the suspension lugs. The dimensions of the bombs are as follows:

Bomb	Over-all Length (in)	Diameter Maximum of Body (in)
Mk 81 Mod 1	76.1	9.00
Mk 82 Mod 1	90.9	10.75

The span of the fins is 1.4 times the maximum diameter of the bomb body. The Mk 81 and Mk 82 bombs weigh approximately 250 and 500 pounds, respectively.

During the tests discussed in this report, the Mk 81 and Mk 82 bombs were released from the Aero 7A bomb ejector rack. Two Mk 2 Mod 0 ejector cartridges were employed when the Mk 81 bombs were released, while one Mk 1 Mod 0 and one Mk 2 Mod 0 cartridge was employed when the Mk 82 bombs were released.

SEPARATION EFFECTS AND FLIGHT CHARACTERISTICS

1. Procedure

Thirty-two Mk 81 and Mk 82 bombs were released from A3D aircraft during the period of March through July 1957 at the following conditions:

Bomb Type	Number of Bombs	Release Altitude (ft)	True Air Speed (knots)
Mk 81 Mod 1	8	10,200	250
Mk 81 Mod 1	6	10,200	390
Mk 81 Mod 1	1	10,200	500
Mk 81 Mod 1	1	4,000	450
Mk 82 Mod 1	3	10,300	270
Mk 82 Mod 1	5	10,000	400
Mk 82 Mod 1	1	7,200	400
Mk 82 Mod 1	2	7,000	480
Mk 82 Mod 1	3	10,000	520
Mk 81 Mod 1	2	10,100	510

The test equipment and procedures were similar to those described in reference (d). The ranges of four bombs were not obtained and the flight characteristics of one of these four bombs were not determined because of instrumentation failures.

2. Flight Characteristics

Information on the yaw histories of the bombs may be obtained from the plots of the apparent attitude given in Figures 1 through 22 in Appendix C. The apparent attitude of the bomb is defined as the projection on a filmplane of the angle between the vertical and the axis of the bomb. The projected angle is measured in the photographs taken at a camera station counter-clockwise from the vertical film

coordinate axis to the nose of the bomb. Since the camera follows the bomb as it falls and since, in general, the bomb turns downward as the velocity vector turns, there would be a change in apparent attitude even if the bomb had zero yaw. Figures 1 through 22 present the apparent attitude of the bomb as measured in photographs taken either at Camera Station 3B, which is located 7000 feet to the left of and approximately perpendicular to the trajectory at release, or from camera station Spy Hill which is similarly located on the right of the trajectory. These attitude plots are useful in determining the yaw damping characteristics of bombs qualitatively, and in comparing the damping characteristic of those bombs released under the same conditions and photographed by the same camera. In addition, the measurements of the attitude of the bomb made on the photographs taken by these camera stations was used to compute the first and second maximum yaw of the bombs (which is given in Tables 2 through 10). The magnitude of the first maximum yaw depends on the ejection force (which is applied aft of the center of gravity causing the bomb to enter the air stream in a tail-down position) and the airflow around the aircraft. In reference (b) it was noted that the airflow tended to decrease tail-down yaw. To the extent that such comparisons can be made, the results obtained during these tests also indicate a decrease in initial yaw with an increase in air speed (compare the yaw data given in Table 5 with that given in Table 7 or Table 8).

Tables 9 and 10, Appendix B, give the flight characteristics observed during previous tests of the Mk 81 and Mk 82 bombs released from the A3D-1 aircraft equipped with the Aero 7A bomb ejector rack (these results were previously reported in NPG Technical Memorandum No. K-11/57; the tests were not instrumented to obtain ranging data).

A summary of all available data on the flight characteristics of the Mk 81 and Mk 82 bombs released from the A3D aircraft at the Naval Proving Ground is given in Table 1 (the table includes data given in reference (b), which deals principally with the bombs equipped with nose fuze, as well as the data given in Tables 2 through 10 of this report). The table shows the ratio of the number of bombs which developed bad flight to the total number of

bombs tested at a given condition (where a bomb was not observed in flight, a conclusion concerning the performance of the bomb was arrived at by comparing the range of the bomb with the average range(1) of all bombs dropped under the same nominal release conditions).

Some of the bombs which had bad flight had large yaw throughout their trajectories while others exhibited instability for a relatively short time (large differences were noted even in the cases where the instability was brief, however). In all instances where the information could be obtained the instability was found to have occurred during a time when the spin and the yaw rates of the bomb were equal. The tendency of the bombs to "lock" in spin at the yaw resonance rate had been noted earlier for the experimental models of these bombs (see references (d) and (e). However, in the case of the tests discussed in this report, the percentage of bombs which exhibited instability (22%) was so large that they are not considered suitable for service use when released from the A3D aircraft (this conclusion had already been reached for the bombs equipped with nose fuze in reference (b).

Of course, one must consider that if there is any correlation between instability and the air speed of release, conclusions about the flight of the bombs over a range of air speeds will be affected by the number of bombs tested at the various air speeds. Actually, there is an indication of a correlation with air speed since the Mk 82 bombs with nose plug appear to be satisfactory at medium air speed and unsatisfactory at low air speeds. If the correlation with air speed is real, the reason for the correlation is not readily apparent (though it may result from a correlation between initial yaw and air speed, which will be discussed in more detail in a forthcoming report). Although it is possible that either the Mk 81 bomb or the Mk 82 bomb with a particular configuration (c.g., with nose plug) would (when it is released under a particular set of release conditions (e.g.) at moderate air speeds) have

(1) Corrected to nominal release and standard atmospheric conditions.

TABLE 1

SUMMARY OF THE FLIGHT CHARACTERISTICS OF
MK 81 AND MK 82 BOMBS RELEASED FROM THE A3D AIRCRAFT(1)

Air Speed Interval	True Air Speed (kts)	Release Altitude (ft)	Ejector Cartridges		Mk 81 Bomb		Mk 82 Bomb	
			Mk 81	Mk 82	Nose Fuze	Nose Plug	Nose Fuze	Nose Plug
	220	7,500	2 Mk 2 Mod 0 1 Mk 2 Mod 0	1 Mk 1 Mod 2 1 Mk 2 Mod 0	0/1	1/3	1/4	
	240	10,000	1 Blank			1/1		
Low	250	10,000	2 Mk 2 Mod 0	1 Mk 1 Mod 2 1 Mk 2 Mod 0		0/9	2/4	
	265	10,000	2 Mk 2 Mod 0		1/6			
100-300 kts	270	10,000		1 Mk 1 Mod 2 1 Mk 2 Mod 0				3/3
	280	10,000	1 Mk 2 Mod 0 1 Blank		0/1			
	300	5,000	2 Mk 2 Mod 0 1 Mk 2 Mod 0		0/1			0/1
	300	10,000	1 Blank		0/1			
	310	2,000		1 Mk 1 Mod 2 1 Mk 2 Mod 0			0/1	
	350	5,000	2 Mk 2 Mod 0		1/1			0/1
Medium	350	10,000	2 Mk 2 Mod 0			0/1		
310-400 kts	360	2,000		1 Mk 1 Mod 2 1 Mk 2 Mod 0			0/1	
	390	10,000	2 Mk 2 Mod 0			1/5		
	400	2,000		1 Mk 1 Mod 2 1 Mk 2 Mod 0			0/1	
	400	5,000	2 Mk 2 Mod 0		0/1			0/2
	400	10,000		1 Mk 1 Mod 2 1 Mk 2 Mod 0				0/5
	450	4,000	2 Mk 2 Mod 0		0/1			
	455	1,500		1 Mk 1 Mod 2 1 Mk 2 Mod 0				0/1
High	480	7,000		1 Mk 1 Mod 2 1 Mk 2 Mod 0				0/2
410-600 kts	490	10,000		1 Mk 1 Mod 2 1 Mk 2 Mod 0			2/2	
	500	10,000	2 Mk 2 Mod 0			0/1(2)		
	520	1,000		1 Mk 1 Mod 2 1 Mk 2 Mod 0				0/3
Total					2/13	3/20	5/13	3/18

Notes: (1) Ratio of the number of bombs with poor flight to the total number of bombs on which data were obtained.

(2) This bomb fell 2000 feet short of bombing table range; however, it had stable flight.

acceptable flight characteristics. Tests to determine a set of these conditions for a particular configuration are not recommended in view of the cost and the small assurance of success of such tests.

3. Range Comparison

Tables 2 through 8, Appendix A, gives the observed range (corrected to nominal release conditions), the bombing table range (computed for the nominal release conditions and the aerodynamic drag assumed in the preparation of the appropriate bombing table) and the range differences (bombing table range minus observed range) for the Mk 81 and Mk 82 bombs dropped during the subject tests. In addition, the tables give the first and second maximum yaw of the bomb; these values are the maximum tail down pitch and subsequent nose down pitch of the bomb, respectively, as it emerges from the bomb bay. The damping time is the time from release to the time when the yaw of the bomb appeared to have damped to about 10 degrees. Variations in damping time of from four to eight seconds are not significant; first, because of the gradual damping of the yaw, which makes the time difficult to define, and, second, because the values are estimated from the attitude histories given in the figures of Appendix C and are therefore dependent on the orientation of the camera with respect to the bomb trajectory. (The correlation between damping time and range differences has not been studied because in addition to the above factors, bombs for which the same damping time is given frequently had different yaw histories before and after the given damping time.)

In general, the bombs which had acceptable flight characteristics also had acceptable dispersion. The bombs listed in Tables 2, 3 and 7 had about 100 feet, or ten mils, dispersion; not enough of the bombs listed in the remaining tables (for other release conditions) were dropped at the same condition to permit the drawing of a conclusion relative to this dispersion. In one instance (see Table 4, Domb 33), a bomb, despite good flight characteristics, fell exceptionally short of bombing table range. This bomb was dropped at a high air speed where initial yaw results in a larger range effect.

A significant result of the tests is that differences of the order of 500 feet were noted between the observed and bombing table range. The differences, which result from the initial yaw of the bombs, are large enough to lead to the conclusion that current bombing tables are not applicable to drops of the Mk 81 and Mk 82 bombs from the A3D aircraft. The results will be studied closely in order to establish the best method of incorporating the effects of initial yaw in the computation of bombing tables, since the procedure will be needed for bombs which are launched with large yaw but subsequently have acceptable flight characteristics.

CONCLUSIONS

It is concluded that:

a. A large percentage (about 20%) of Mk 81 and Mk 82 bombs with nose plug and with mechanical nose fuzes (considered collectively) will develop unstable flight when released from the A3D aircraft equipped with the Aero 7A ejector rack using current service cartridges.

b. As a result of erratic ranges resulting from frequent occurrences of unstable flight, the Mk 81 and Mk 82 bombs with nose plug and with mechanical nose fuze (considered collectively) are unsuitable for service use with the A3D aircraft equipped with the Aero 7A ejector rack using current service cartridges.

c. Tests should not be conducted to determine conditions at which the Mk 81 or Mk 82 bombs with nose plug or with nose fuze (considered separately) would have acceptable flight characteristics when released from the A3D aircraft at service conditions because such tests would be too expensive and have too little assurance of success.

d. The Mk 81 and Mk 82 bombs with nose fuze and nose fuze plug will have large initial yaw when dropped from the A3D aircraft under current service conditions.

e. The initial yaw of the bombs will result in ranges considerably shorter (of the order of 500 feet when the bombs are released from 10,000 feet altitude at low and moderate air speeds) than those given in bombing tables computed for zero initial yaw, even when the yaw damps satisfactorily.

f. The effects of initial yaw of the magnitude encountered in the subject test (30 to 60 degrees) will have to be considered in the preparation of bombing tables when such yaws occur.

RECOMMENDATIONS

It is recommended that the Mk 81 and Mk 82 bombs be deleted from the list of armament capabilities of the A3D aircraft equipped with the Aero 7A ejector rack and current service cartridges.

FUTURE PLANS

The following actions, which are closely related to the subject tests, are being taken:

a. Tests of the Mk 83 bomb dropped from A3D aircraft are under way.

b. A report of the correlation of initial yaw with release speed will be made for the Mk 81 and Mk 82 bombs released from the A3D aircraft.

c. A report of the comparison of observed and computed effects of initial yaw will be made for the Mk 81 and Mk 82 bombs released from the A3D aircraft.

REFERENCES

(a) BUORD ltr ReW4d-TFG:bc X5/2 of 4 Oct 1956
(b) J. J. Madden, Separation and Free Flight Tests of 250-lb Mk 81 and 500-lb Mk 82 Low Drag G.P. Bombs Released from A3D-1 Aircraft (NPG Conf Report No. 1551 of 16 August 1957

(c) Ordnance Pamphlet 1280 (1st Rev.)
(d) C. H. Wingo, [illegible], and F. L. Jones, Free Flight and Catapult Tests of the 250-lb Low Drag G.P. Bomb Types EX-2 Mod 2 and EX-2 Mod 2A, 250-lb Low Drag Fragmentation Bomb Type EX-17 Mod 6, 2000-lb Low Drag G.P. Bomb Type EX-11 Mod 1 with Canted Fins. (NPG Conf Report No. 1419 of 17 Oct 1955)
(e) C. H. Wingo, Jr., Free Flight Tests of 500-lb Low Drag G.P. Bomb EX-12 Mod 4. (NPG Conf Report No. 1469 of 5 Jun 1956)

APPENDIX A

TABLE 2

APPLICABILITY OF AVAILABLE BOMBING TABLE DATA(1)
TO DROPS OF THE MK 81 MOD 1 BOMB FROM A3D-1 AIRCRAFT

Nominal Release Conditions
Altitude — Horizontal Flight
True Air Speed — 10,200 feet
Fuze — 250 knots
Nose Plug

Date 1957	Time of Day	Bomb(2) No.	Rack(3) Location	First Maximum Yaw (deg)	Second Maximum Yaw (deg)	Damping(7) Time (sec)	Bombing(4) Table Range (ft)	Corrected(5) Observed Range (ft)	Range(6) Difference (ft)
7-10	0958	29	3 Fwd	73	-49	7	10220	9726	494
7-10	1032	25	2 Fwd	-(8)	-(8)	8	10220	9596	624
7-10	1040	26	2 Aft	-(8)	-40	6	10220	9695	525
7-10	1047	28	1 Fwd	63	-52	6	10220	9670	550
7-10	1057	30	1 Aft	-(8)	-(8)	4	10220	9747	283
7-10	1326	16	1 Aft	-(8)	-(8)	5	10220	9675	545
7-10	1611	37	1 Fwd	58	-51	7	10220	9707	513
7-10	1617	38	1 Aft	55	-45	4	10220	9801	419
Mean									494
Standard Deviation of Individual Observations									104
Standard Error of Mean									37

TABLE 3

APPLICABILITY OF AVAILABLE BOMBING TABLE DATA(1)
TO DROPS OF THE MK 81 MOD 1 BOMB FROM A3D-1 AIRCRAFT

Nominal Release Conditions
Altitude — Horizontal Flight
True Air Speed — 10,200 feet
Fuze — 390 knots
Nose Plug

Date 1957	Time of Day	Bomb(2) No.	Rack(3) Location	First Maximum Yaw (deg)	Second Maximum Yaw (deg)	Damping(7) Time (sec)	Bombing(4) Table Range (ft)	Corrected(5) Observed Range (ft)	Range(6) Difference (ft)
7-10	1352	32	3 Fwd	-(8)	-(8)	6	15,489	14,046	1443(9)
7-10	1300	21	3 Aft	-(8)	-(8)	3	15,489	14,816	673
7-10	1306	27	2 Fwd	-(8)	-(8)	4	15,489	14,970	519
7-10	1313	22	2 Aft	-(8)	-(8)	4	15,489	14,795	694
7-10	1321	23	1 Fwd	-(8)	-(8)	4	15,489	14,894	611
7-10	1026	31	3 Aft	-(8)	-(8)	4	15,489	(8)	(8)
Mean									624
Standard Deviation of Individual Observations									81
Standard Error of Mean									40

TABLE 4

APPLICABILITY OF AVAILABLE BOMBING TABLE DATA(1) TO DROPS OF THE MK 81 MOD 1 BOMB FROM A3D-1 AIRCRAFT

Date 1957	Time of Day	Bomb(2) No.	Nose Fuze	Altitude (ft)	True Air Speed (kts)	Rack(3) Location	First Maximum Yaw	Second Maximum Yaw	Damping(7) Time	Bombing(4) Table Range (ft)	Corrected(5) Observed Range (ft)	Range(6) Difference (ft)
3-21	1531	47	AN/M103A1	4,000	450	3 Fwd	-(8)	-(8)	5	15801	16525	276
7-10	1532	34	Plug	10,100	510	(6)	49	-42	3	-(8)	-(8)	-(8)
7-10	1552	36	Plug	10,100	510	(6)	-(8)	-(8)	-(8)	-(8)	-(8)	-(8)
7-10	1601	33	Plug	10,100	500	2 Aft	49	-50	3	19684	17414	2270

TABLE 5

APPLICABILITY OF AVAILABLE BOMBING TABLE DATA(1)
TO DROPS OF THE MK 82 MOD 1 BOMB FROM A3D-1 AIRCRAFT

Nominal Release Conditions
Altitude — Horizontal Flight
True Air Speed — 10,300 feet
Fuze — 270 kts
Nose Plug

Date 1957	Time of Day	Bomb(2) No.	Rack(3) Location	First Maximum Yaw (deg)	Second Maximum Yaw (deg)	Damping(7) Time (sec)	Bombing(4) Table Range (ft)	Corrected(5) Observed Range (ft)	Range(6) Difference (ft)
7-16	1005	25	2 Fwd	56	-53	14	10,804	8,972	1832
7-16	1010	19	2 Aft	66	-45	(10)	10,804	7,808	2996
7-16	1642	22	3 Fwd	53	-44	8	10,804	9,879	925

TABLE 6

APPLICABILITY OF AVAILABLE BOMBING TABLE DATA(1)
TO DROPS OF THE MK 82 MOD 1 BOMB FROM A3D-1 AIRCRAFT

Nominal Release Conditions
Altitude — Horizontal Flight
True Air Speed — 7000 feet
Fuze — 480 knots
Nose Plug

Date 1957	Time of Day	Bomb(2) No.	Rack(3) Location	First Maximum Yaw (deg)	Second Maximum Yaw (deg)	Damping(7) Time (sec)	Bombing(4) Table Range (ft)	Corrected(5) Observed Range (ft)	Range(6) Difference (ft)
7-16	1413	15	2 Fwd	-(8)	-(8)	4	15,810	15,476	334
7-16	1725	17	2 Aft	-(8)	-(8)	4	15,810	15,423	387

TABLE 7

APPLICABILITY OF AVAILABLE BOMBING TABLE DATA(1)
TO DROPS OF THE MK 82 MOD 1 BOMB FROM A3D-1 AIRCRAFT

Nominal Release Conditions: Horizontal Flight
Altitude: 10,000 feet
True Air Speed: 400 knots
Nose Fuze: Nose Plug

Date 1957	Time of Day	Bomb(2) No.	Rack(3) Location	First Maximum Yaw (deg)	Second Maximum Yaw (deg)	Damping(7) Time (sec)	Bombing(4) Table Range (ft)	Corrected(5) Observed Range (ft)	Range(6) Difference (ft)
7-16	1000	24	3 Aft	59	-35	4	15878	15177	627(11)
7-16	1000	42	2 Aft	-(8)	-(8)	6	15878	-(8)	-(8)
7-16	1400	14	3 Fwd	-(8)	-(8)	4	15878	15677	411
7-16	1410	13	3 Aft	-(8)	-(8)	7	15878	15660	361(12)
7-16	1658	20	2 Fwd	-(8)	-30	7	15878	15628	367
7-16	1711	18	1 Aft	41	-32	4	15878	15495	430
Mean									439
Standard Deviation of Individual Observations									109
Standard Error of Mean									49

TABLE 8

APPLICABILITY OF AVAILABLE BOMBING TABLE DATA(1)
TO DROPS OF THE MK 82 MOD 1 BOMB FROM A3D-1 AIRCRAFT

Nominal Release Conditions
Altitude — Horizontal Flight
True Air Speed — 10,000 feet
Nose Fuze — 530 knots
AN/M103A1

Date 1957	Time of Day	Bomb(2) No.	Rack(3) Location	First Maximum Yaw (deg)	Second Maximum Yaw (deg)	Damping(7) Time (sec)	Bombing(4) Table Range (ft)	Corrected(5) Observed Range (ft)	Range(6) Difference (ft)
7-11	1248	16	3 Fwd	38	-32	4	20,535	20,093	442
7-16	0950	26	3 Fwd	33	-34	4	20,535	20,181	354
7-16	1650	21	3 Aft	-(8)	-38	5	20,575	19,717	792
Mean									529
Standard Deviation of Individual Observations									233
Standard Error of Mean									135

The following notes apply to Tables 2 through 8.

(1) i.e. data given in OP2152 and OP2289 for the Mk 81 and Mk 82 bombs with nose fuze plug, respectively; form factors relative to the Mk 83 drag function (given in reference (d)) of 1.85 and 1.55 for the Mk 81 and Mk 82 bombs with nose fuze, respectively.

(2) Number assigned at NPG before test.

(3) Rack location 1, 2, 3 and 4 are port inboard, port outboard, starboard inboard and starboard outboard, respectively.

(4) Bombing table range computed using the available bombing table data, standard atmospheric conditions, and nominal release conditions.

(5) Observed range corrected to standard conditions indicated.

(6) Bombing table range minus corrected observed range.

(7) Time from release to the time when the yaw of the bomb appeared to have damped to about 10 degrees.

(8) Data not available.

(9) Not used in computation of Mean or Standard Deviation of Individual Observations.

(10) The yaw of this bomb did not damp.

(11) Bomb was released at true air speed of 370 knots but the bomb range was corrected to nominal release conditions of table.

(12) Bomb was released at 7200 feet altitude but corrected the bomb range was to nominal release conditions of table.

APPENDIX B

TABLE 9

FLIGHT CHARACTERISTICS OF THE
250-LB LOW DRAG BOMB MK 81 RELEASED FROM A3D-1 AIRCRAFT

Date 1955	Time	Indicated Altitude (ft)	Nose Configuration	Indicated Air Speed (kt)	Rack(1) Position	First Maximum Yaw(2) (deg)	Second Maximum Yaw(2) (deg)	Damping Time(3) (sec)
8-31	1448	5250	AN-M103A1 Fuze	300	3(5)	-(4)	-30	4
8-31	1500	5400	AN-M103A1 Fuze	350	1	-(4)	-(4)	-(7)
8-31	1515	5250	AN-M103A1 Fuze	400	4(5)	-(4)	-25	6
8-31	1515	5250	AN-M103A1 Fuze	400	2	-(4)	-(4)	-(4)
9-11	1502	9900	Plug	240	3(6)	-(4)	-47	17
9-11	1508	9970	AN-M103A1 Fuze	280	1(6)	43	-35	4
9-11	1520	10300	AN-M103A1 Fuze	300	4	41	-32	6
9-11	1524	10000	Plug	350	2	-(4)	-(4)	4

(1) Rack Positions 1, 2, 3 and 4 are port inboard, port outboard, starboard inboard, and starboard outboard, respectively (all aft positions).

(2) Positive sign indicates nose up.

(3) Time within which the yaw damped to less than 10 degrees.

(4) Insufficient data.

(5) Bomb ejected from Aero 7A ejector rack equipped with two Mk 2 Mod 0 cartridges.

(6) Bomb ejected from Aero 7A bomb ejector rack equipped with one Mk 2 Mod 0 and one blank cartridge.

(7) Bomb had circular yaw (attaining a magnitude of 90°) from release to impact.

TABLE 10

FLIGHT CHARACTERISTICS OF THE
500-LB LOW DRAG BOMB MK 82 RELEASED FROM A3D-1 AIRCRAFT(1)

Date 1956	Time	Indicated Altitude (ft)	Nose Configuration	Indicated Air Speed (ft)	First Maximum Yaw(2) (deg)	Second Maximum Yaw(2) (deg)	Damping Time(3) (sec)
9-5	1540	4950	Plug	300	40	-33	5
9-5	1548	4900	Plug	350	-(4)	-31	5
9-5	1553	4900	Plug	400	-(4)	-37	5
9-5	1558	4600	Plug	400	45	-35	6
9-6	1228	1900	AN-M103A1 Fuze	310	38	-32	5
9-6	1235	2000	Plug	360	-(4)	-36	4
9-6	1243	1500	AN-M103A1 Fuze	400	-(4)	-31	4
9-6	1305	1500	Plug	455	-(4)	-29	5

(1) Data on rack position not available. The bombs were ejected from Aero 7A bomb ejector rack equipped with one Mk 1 Mod 2 and one Mk 2 Mod 0 cartridge.

(2) Positive sign indicates nose up.

(3) Time within which the yaw damped to less than 10 degrees.

(4) Insufficient data.

APPENDIX C

ATTITUDE OF 250 LB BOMB MK 81 RELEASED
AT 250 KNOTS TRUE AIR SPEED

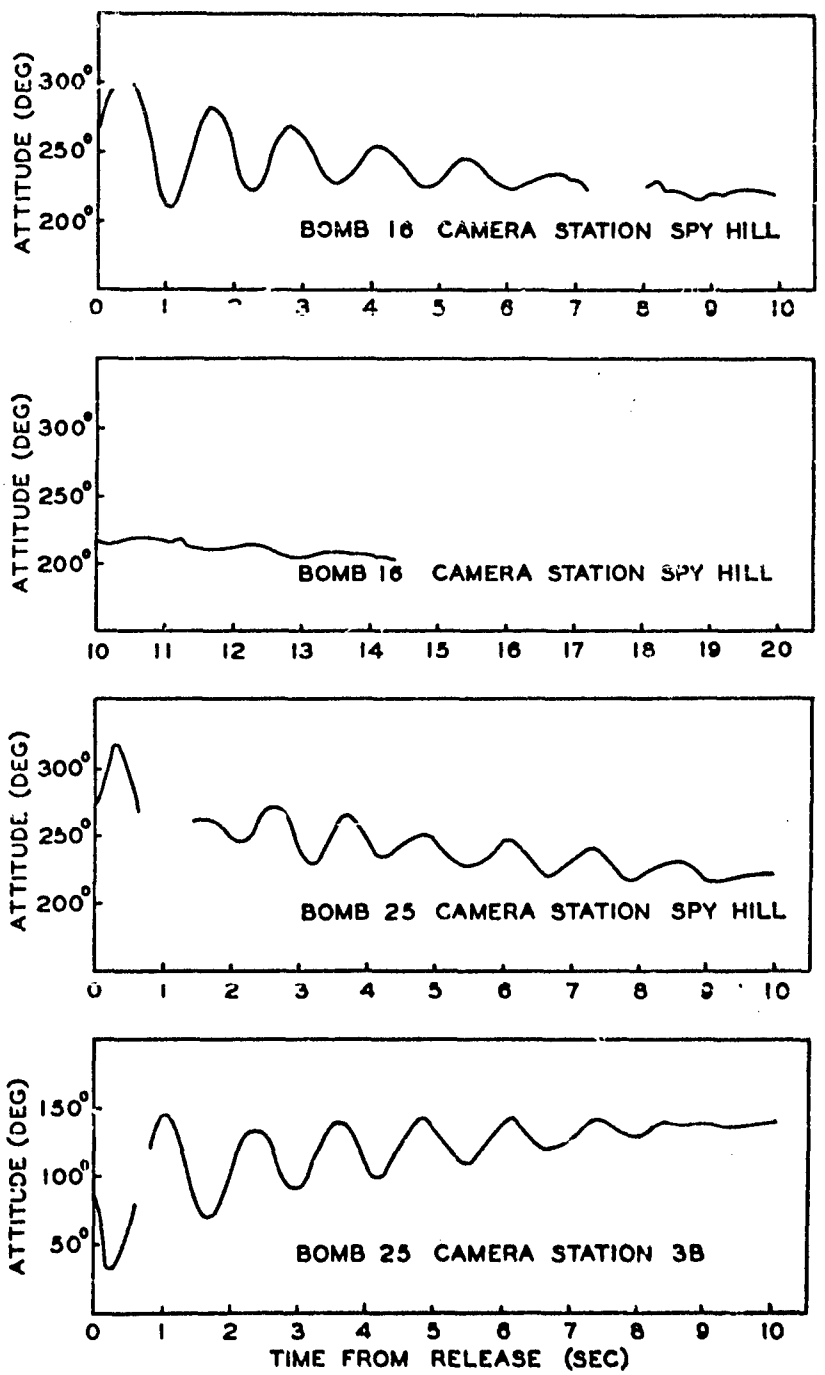

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FIGURE 1

ATTITUDE OF 250 LB BOMB MK 81 RELEASED AT 250 KNOTS TRUE AIR SPEED

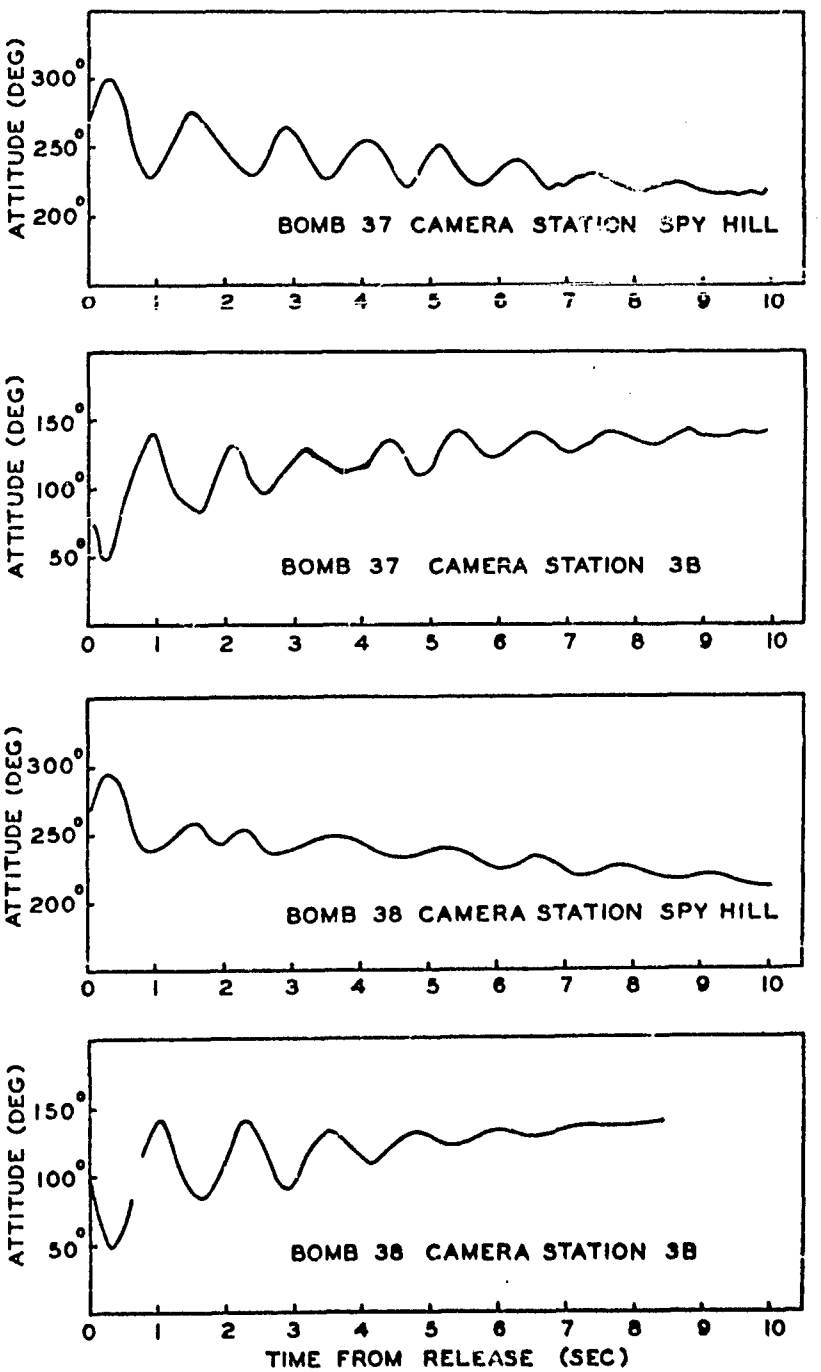

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FIGURE 2

ATTITUDE OF 250 LB. BOMB MK 81 RELEASED
AT 250 KNOTS TRUE AIR SPEED

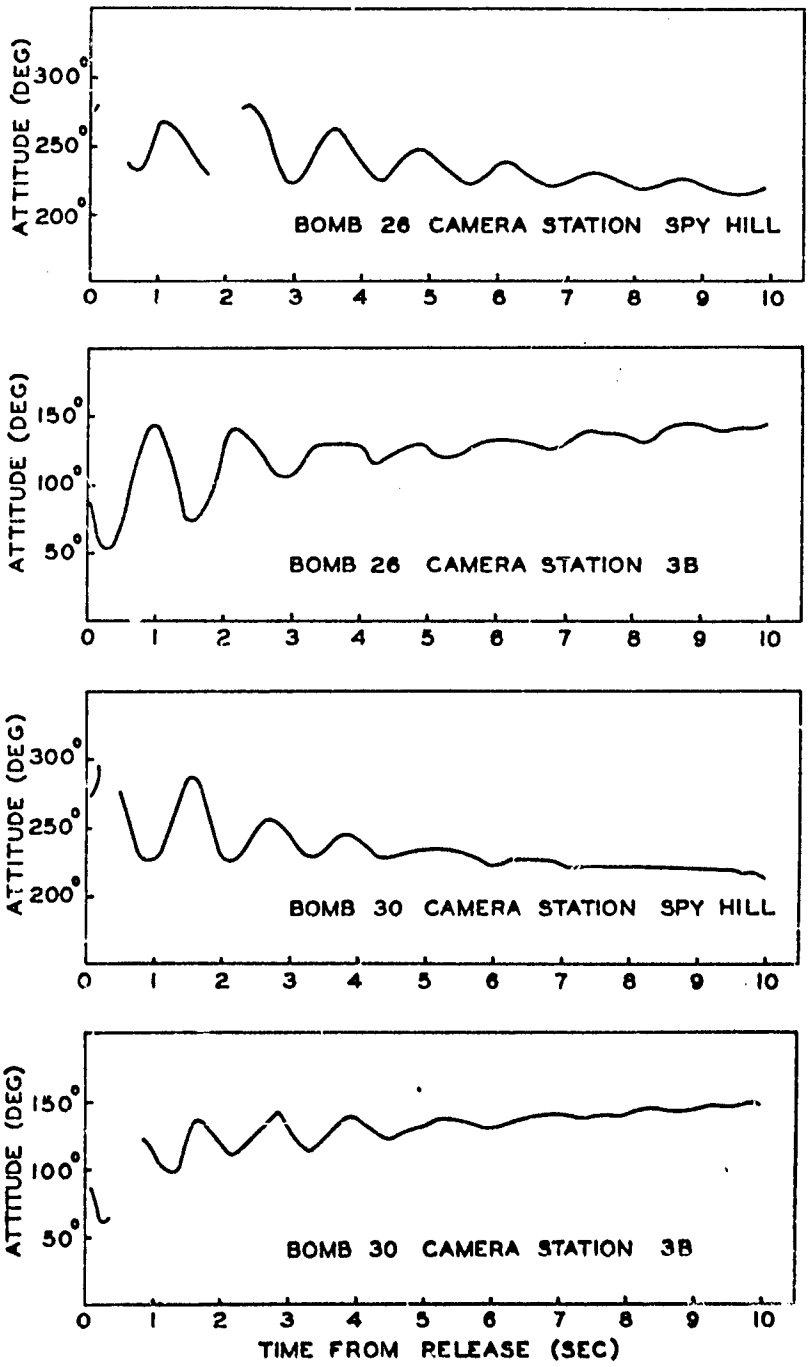

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FIGURE 3

ATTITUDE OF 250 LB. BOMB MK 81 RELEASED
AT 250 KNOTS TRUE AIR SPEED

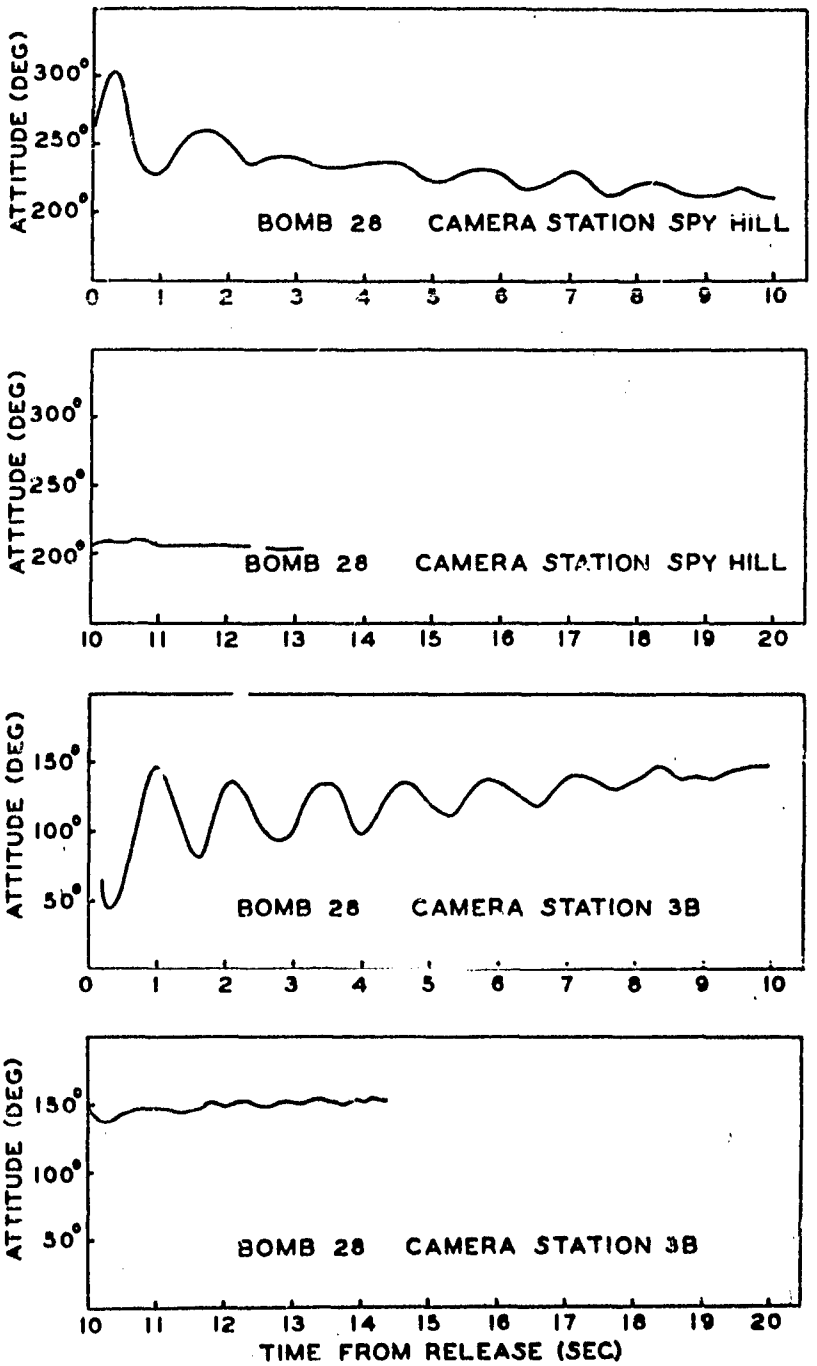

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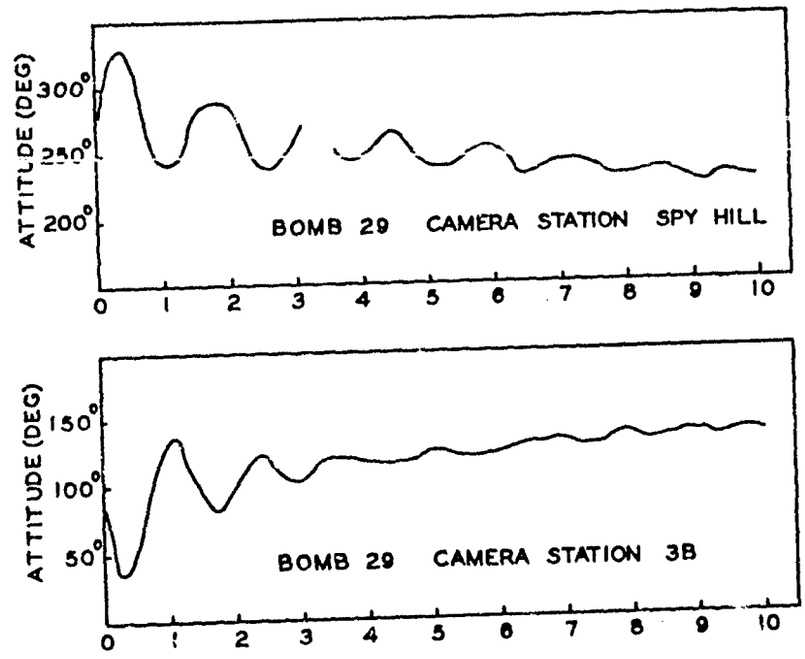
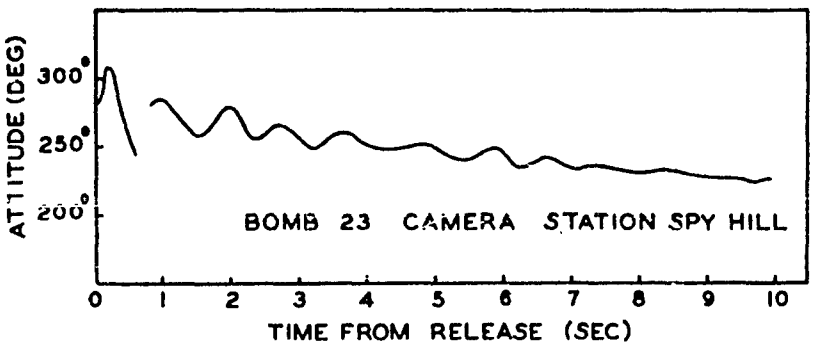
FIGURE 4

ATTITUDE OF 250 LB BOMB MK 81 RELEASED
AT 250 KNOTS TRUE AIR SPEED



CONFIDENTIAL FIGURE 5

ATTITUDE OF 250 LB BOMB MK 81 RELEASED
AT 390 KNOTS TRUE AIR SPEED



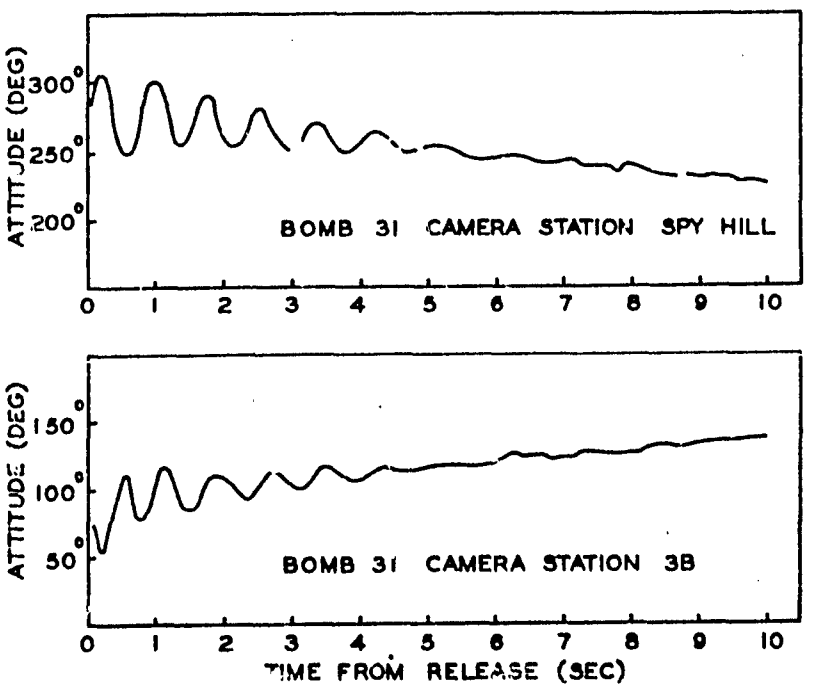


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FIGURE 6

ATTITUDE OF 250 LB BOMB MK 81 RELEASED AT 390 KNOTS TRUE AIR SPEED

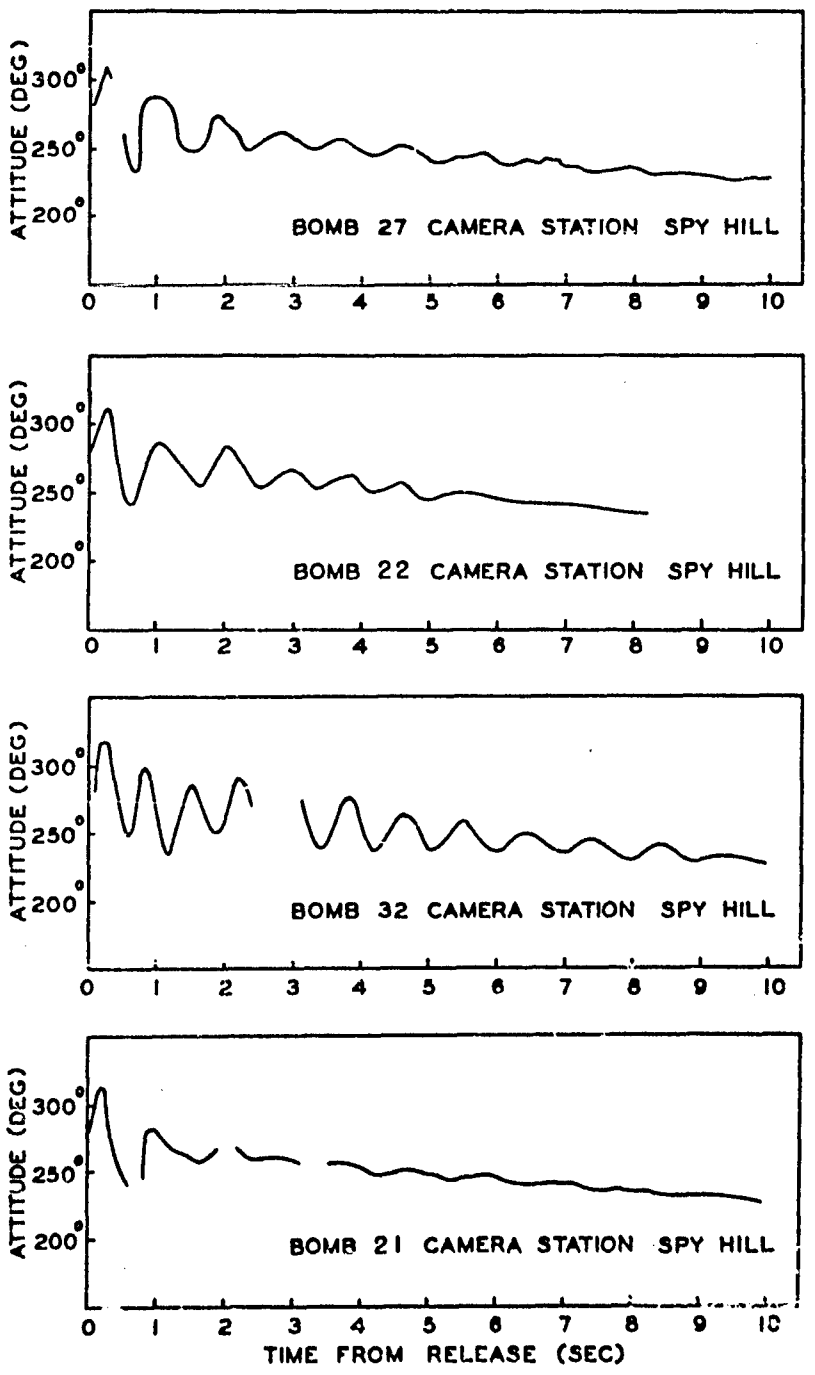

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FIGURE 7

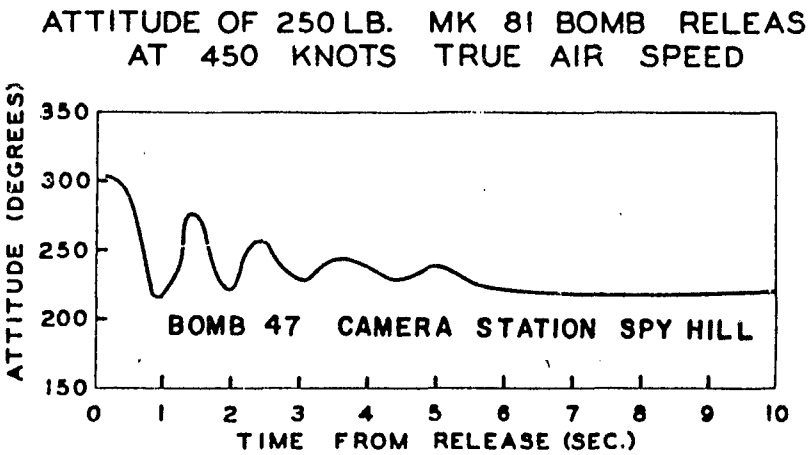

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FIGURE 8

ATTITUDE OF 250 LB BOMB MK 81 RELEASED
AT 500 KNOTS TRUE AIR SPEED

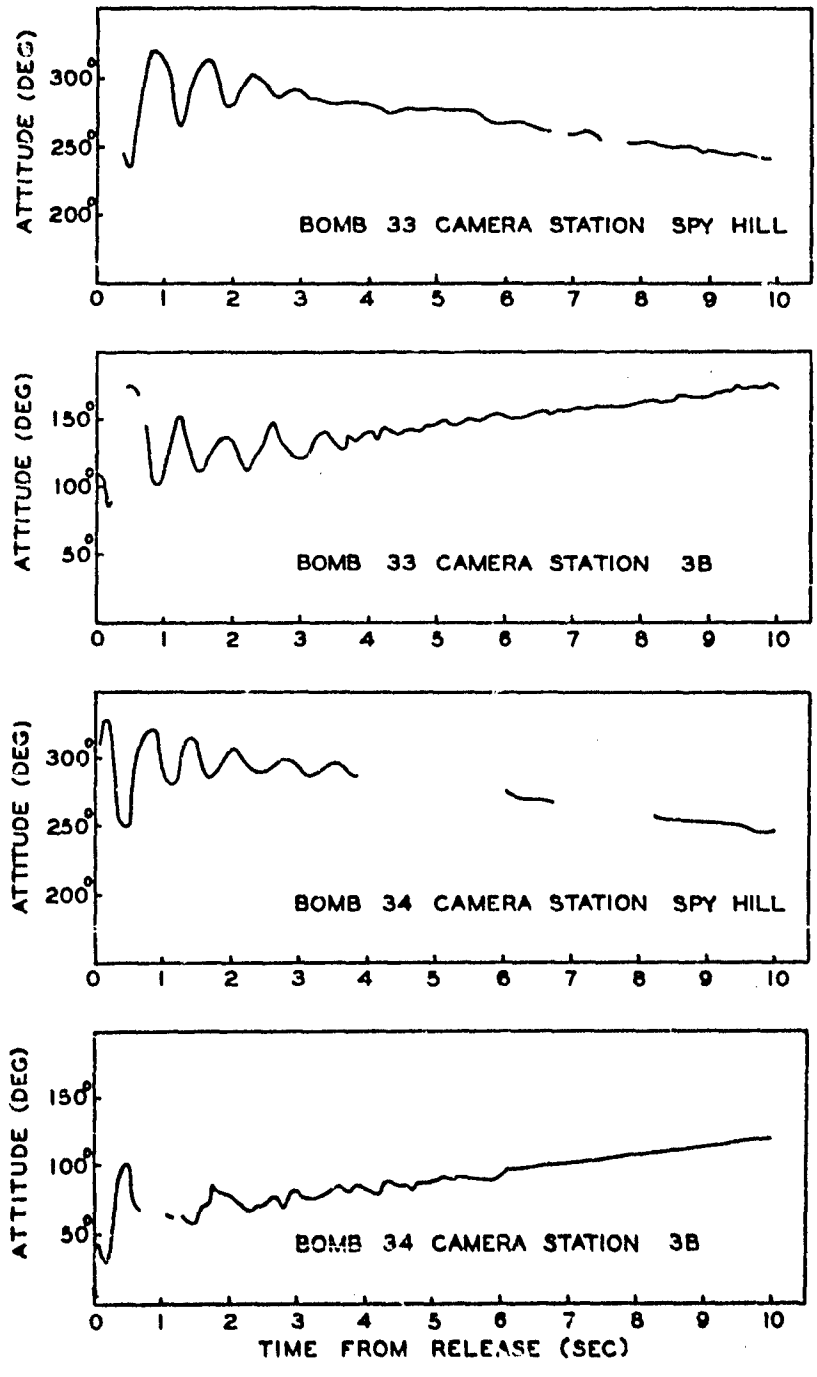

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FIGURE 9

ATTITUDE OF 500 LB BOMB MK 82 RELEASED AT 270 KNOTS TRUE AIR SPEED

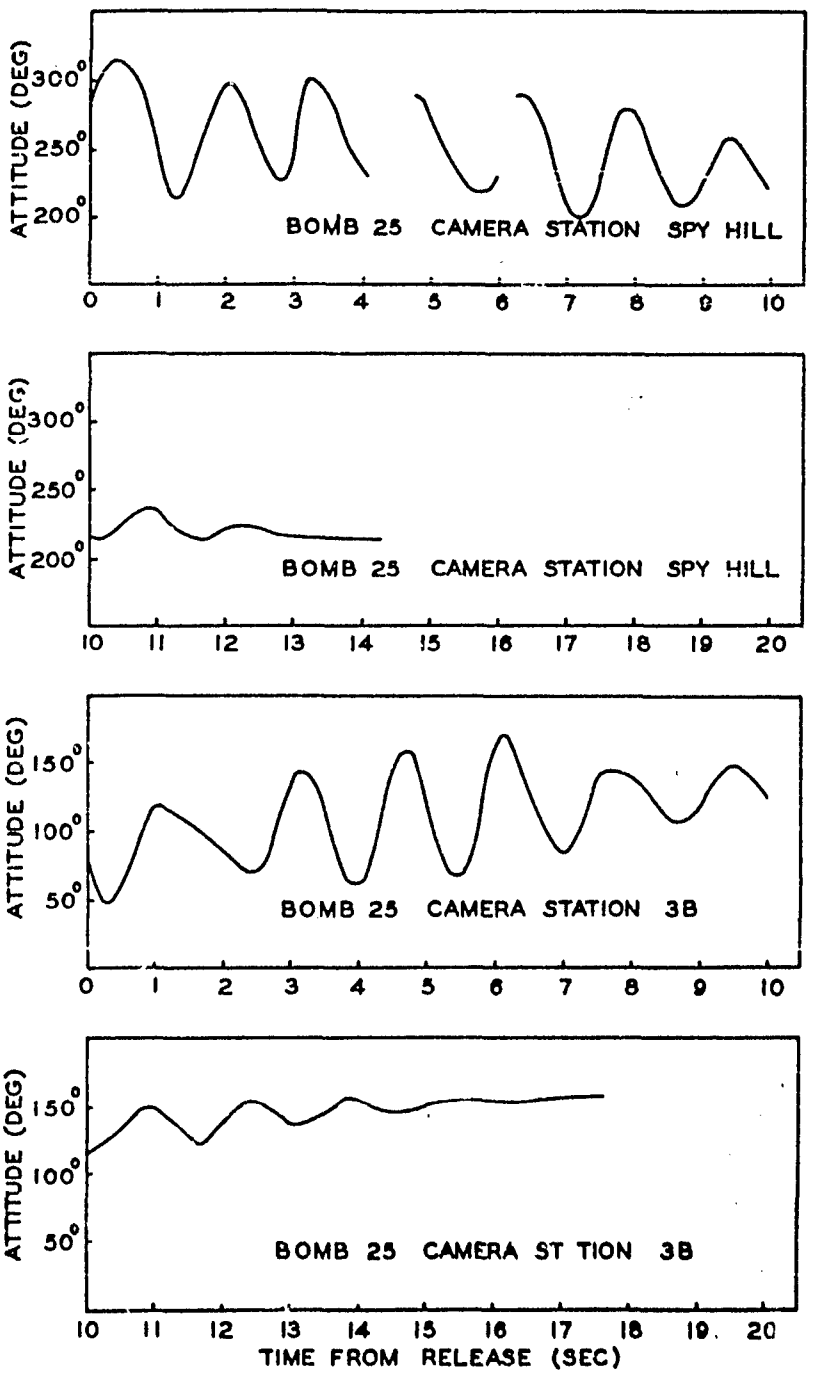

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FIGURE 10

ATTITUDE OF 500 LB BOMB MK 82 RELEASED AT 270 KNOTS TRUE AIR SPEED

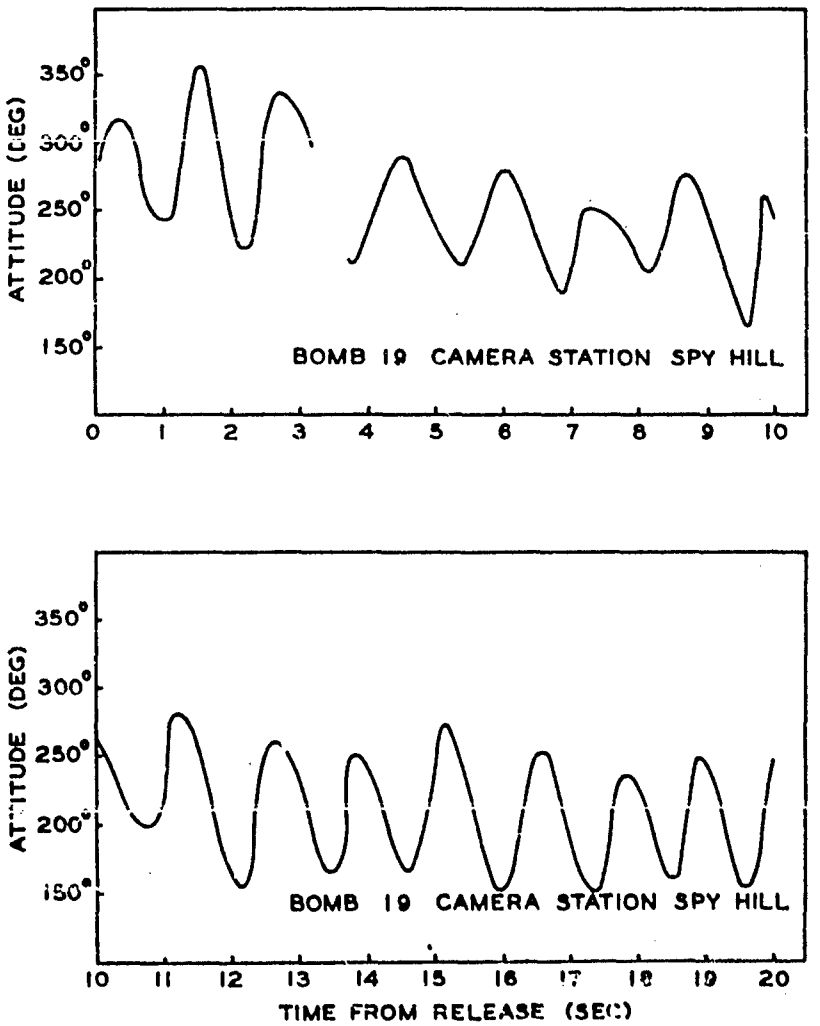

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FIGURE 11

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 270 KNOTS TRUE AIR SPEED

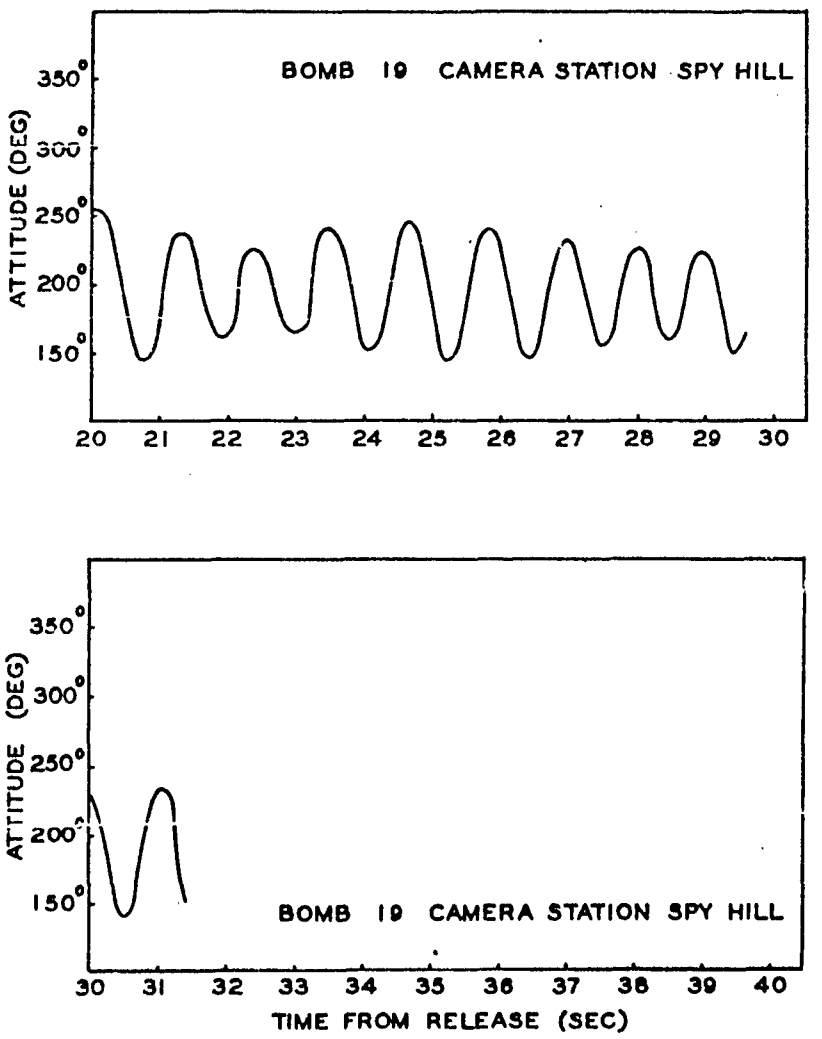

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FIGURE 12

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 270 KNOTS TRUE AIR SPEED

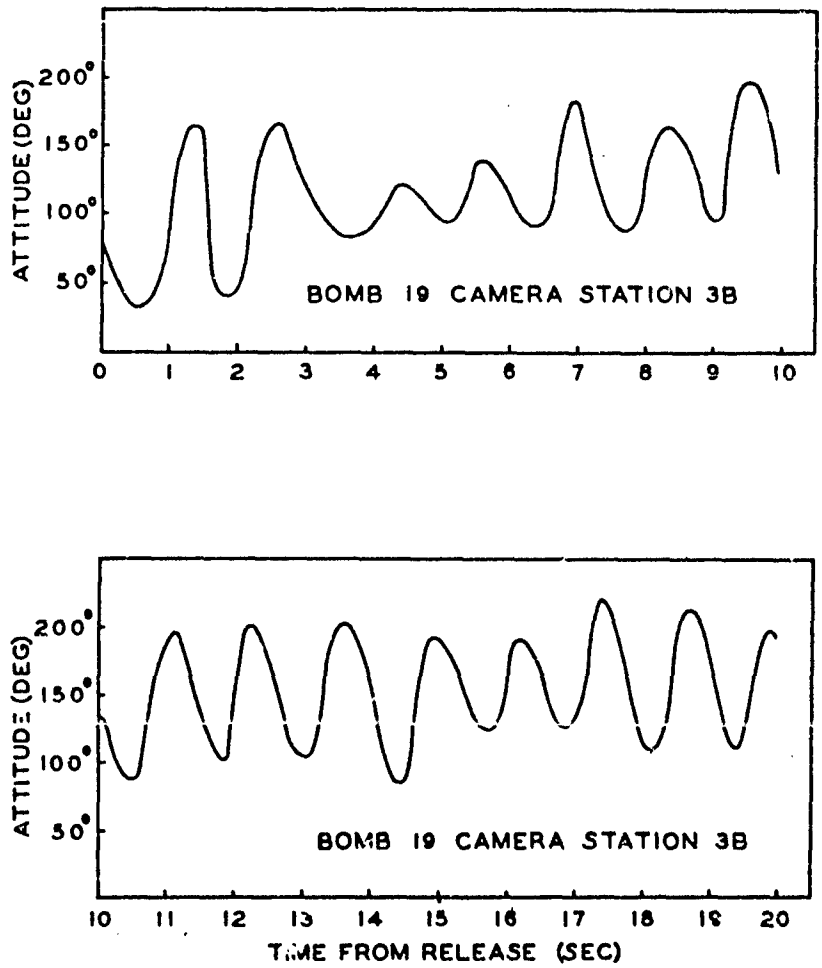

FIGURE 13

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 270 KNOTS TRUE AIR SPEED

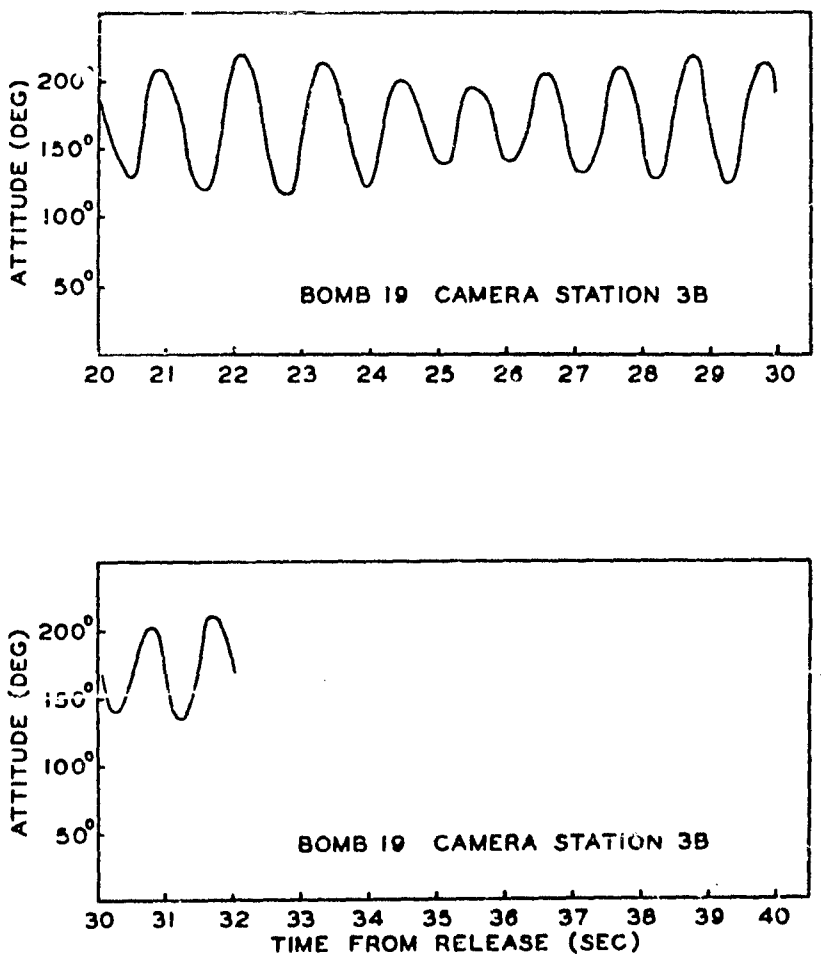

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FIGURE 14

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 270 KNOTS TRUE AIR SPEED

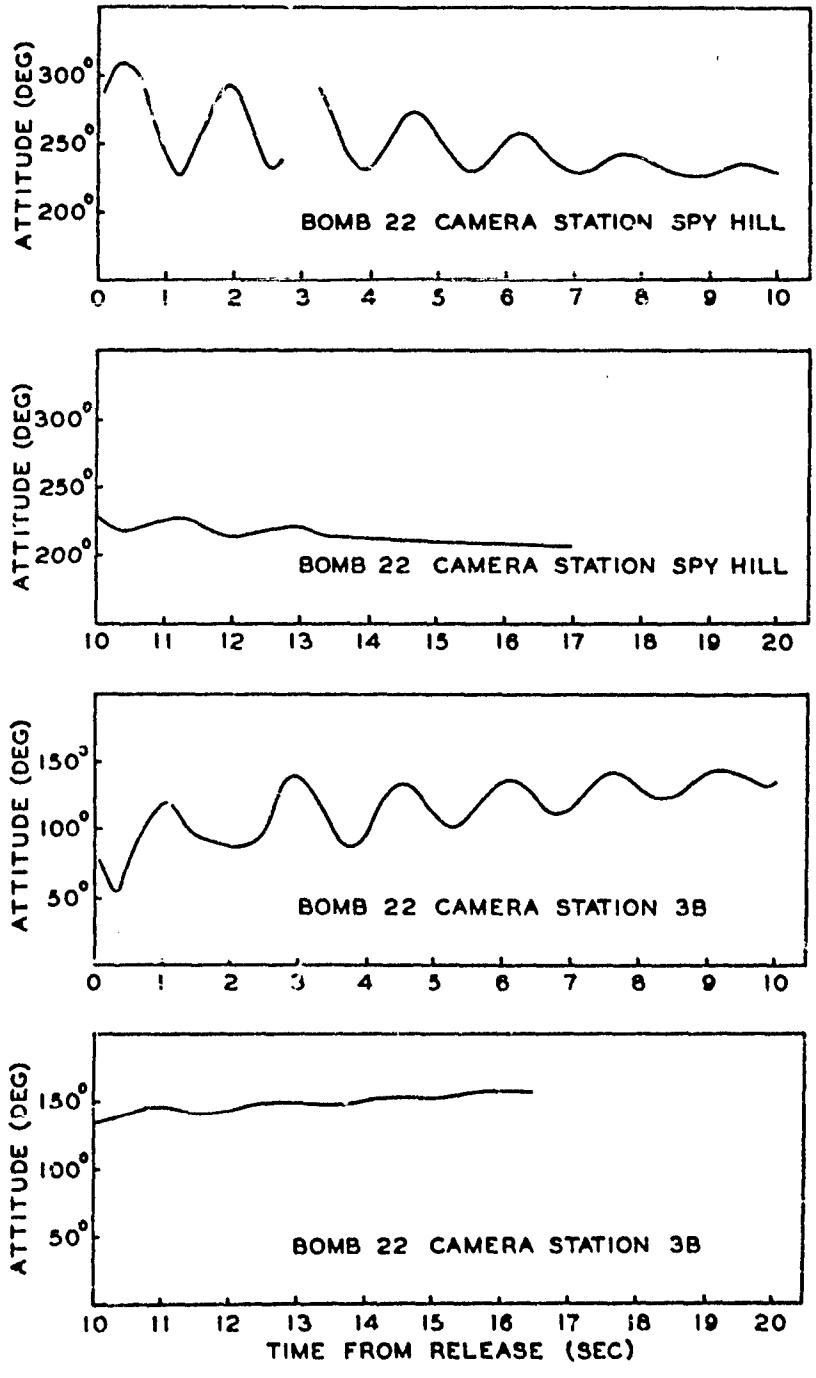

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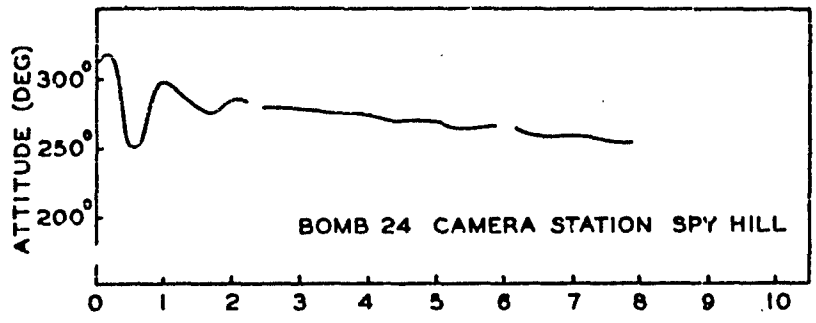
FIGURE 15

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 370 KNOTS TRUE AIR SPEED



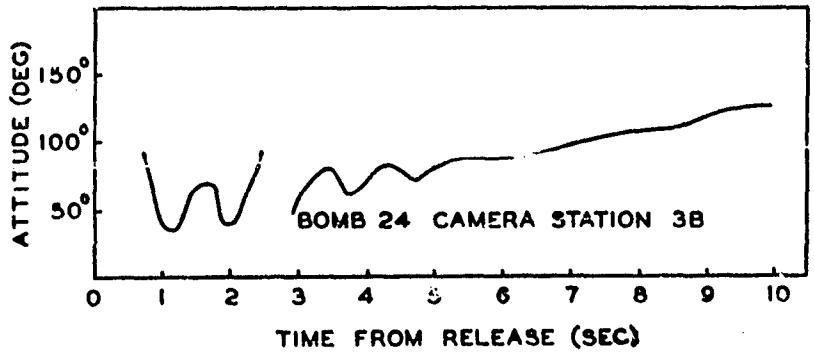


FIGURE 16

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 400 KNOTS TRUE AIR SPEED

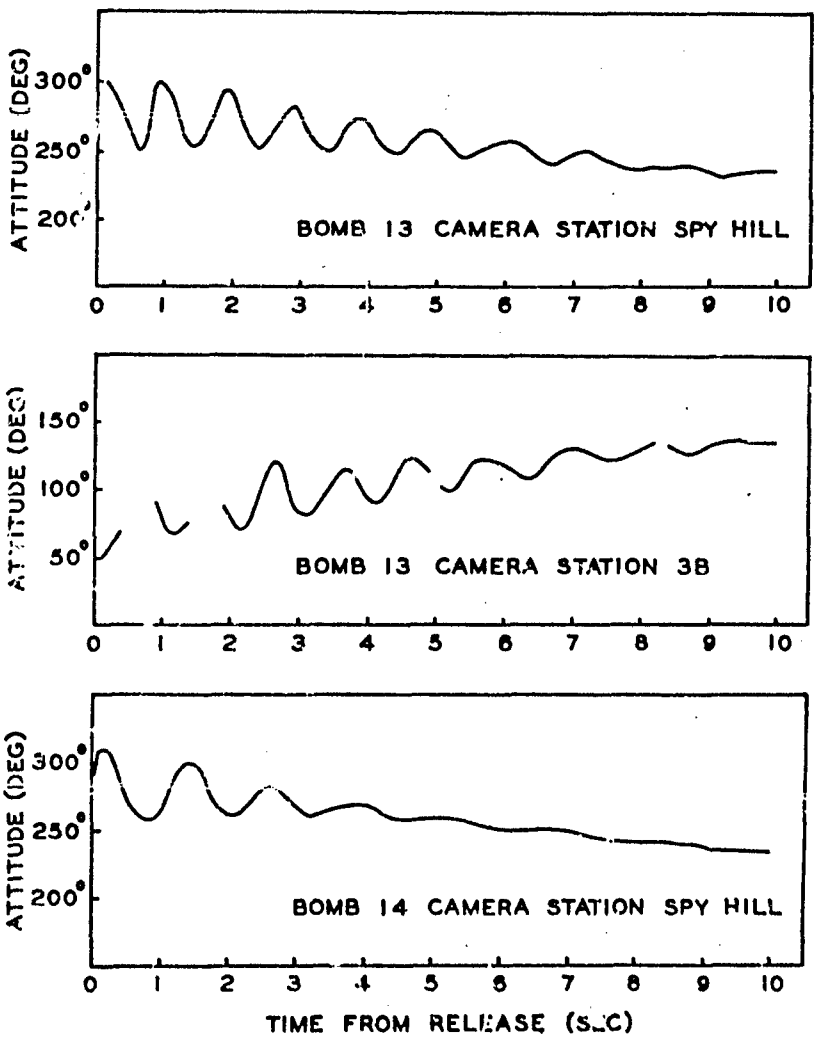


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FIGURE 17

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 400 KNOTS TRUE AIR SPEED

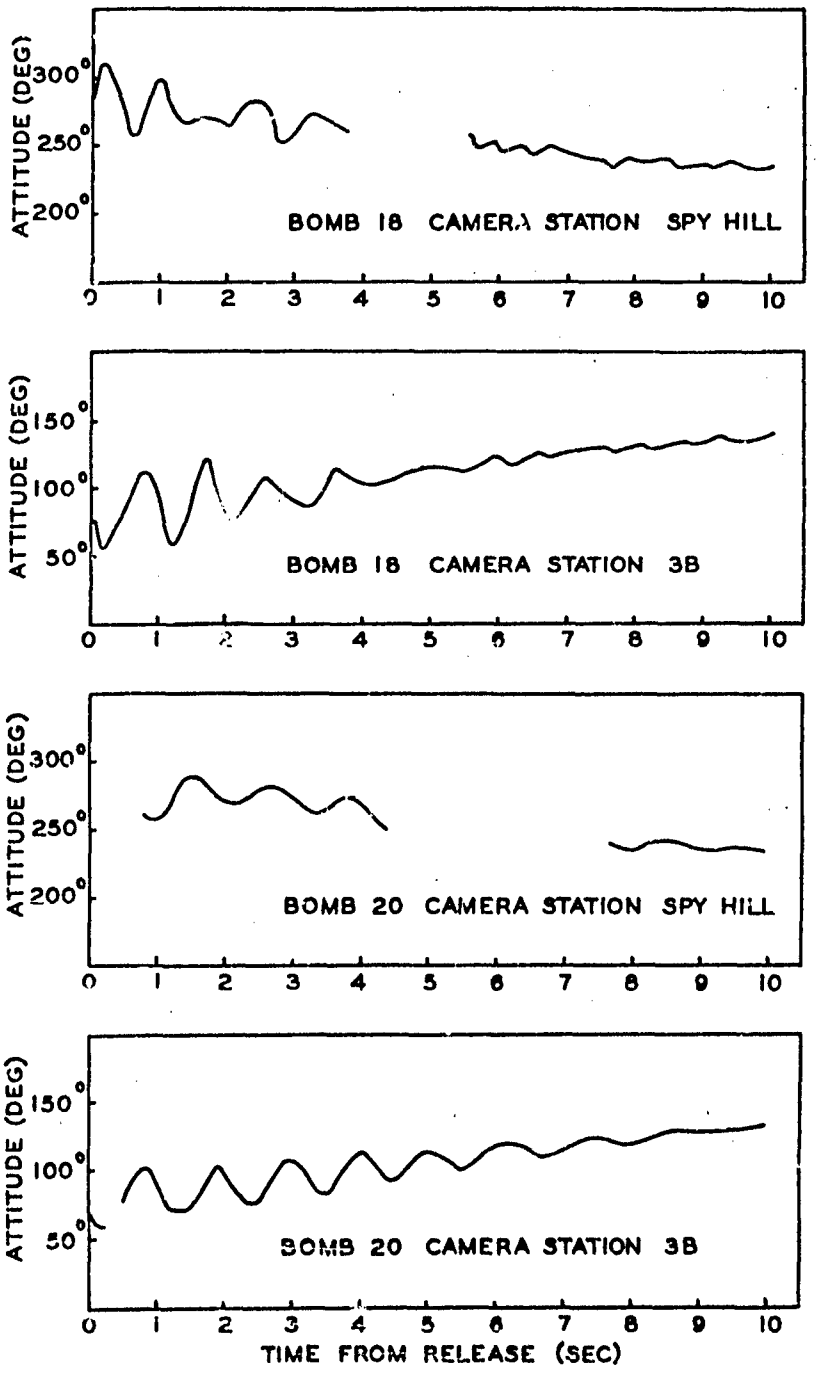

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FIGURE 18

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 400 KNOTS TRUE AIR SPEED

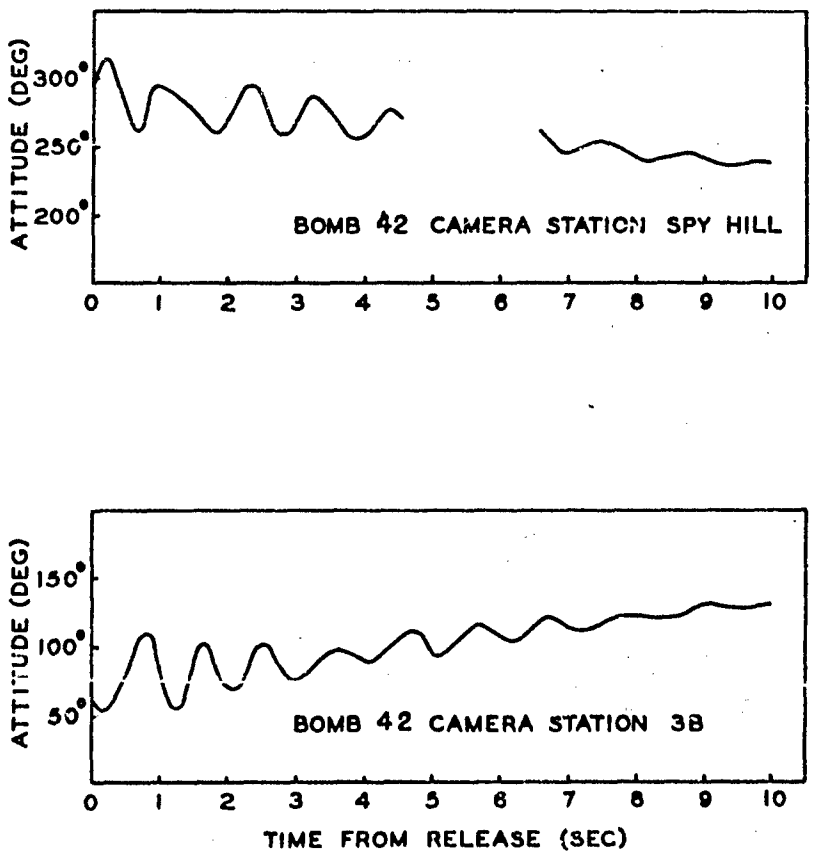

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FIGURE 19

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 480 KNOTS TRUE AIR SPEED

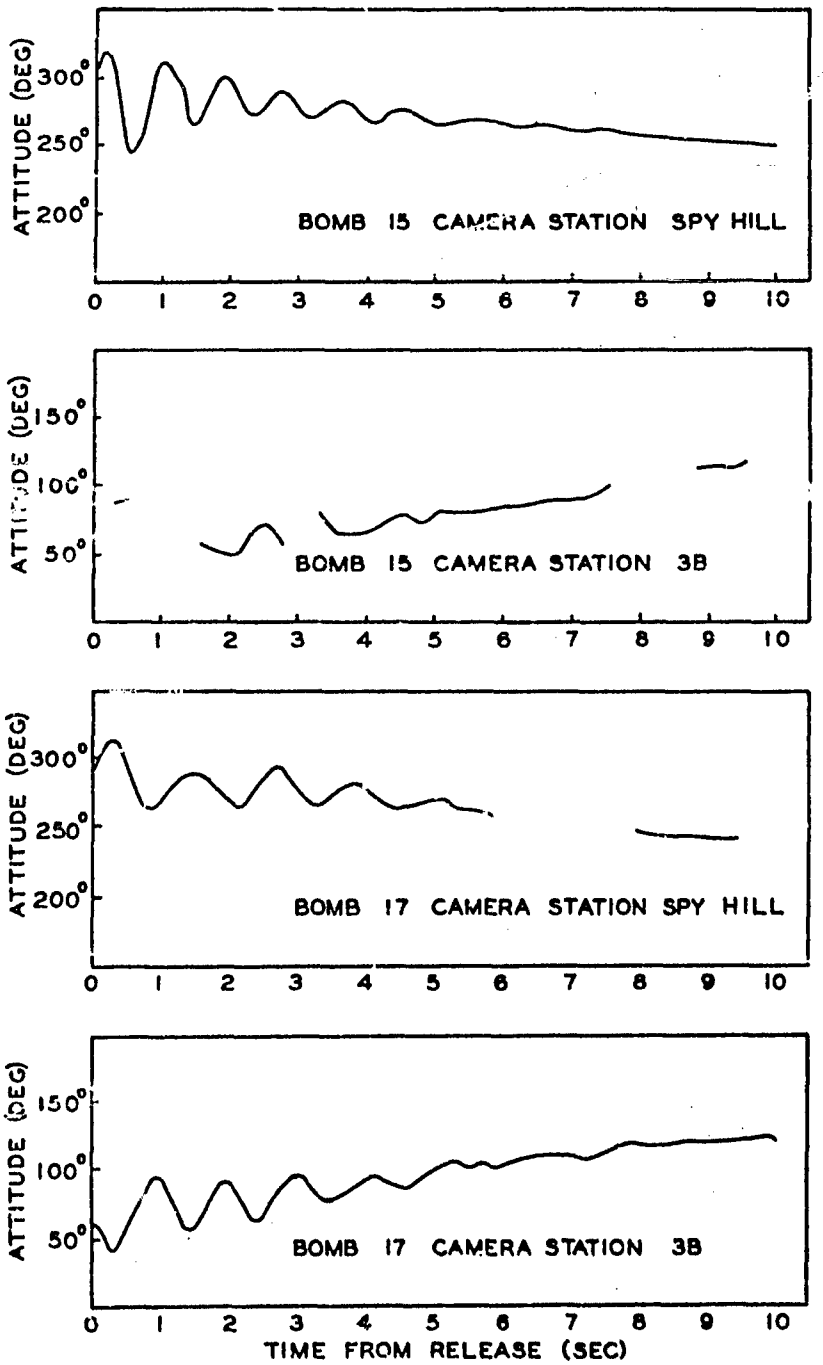

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FIGURE 20

ATTITUDE OF 500 LB BOMB MK 82 RELEASED
AT 520 KNOTS TRUE AIR SPEED

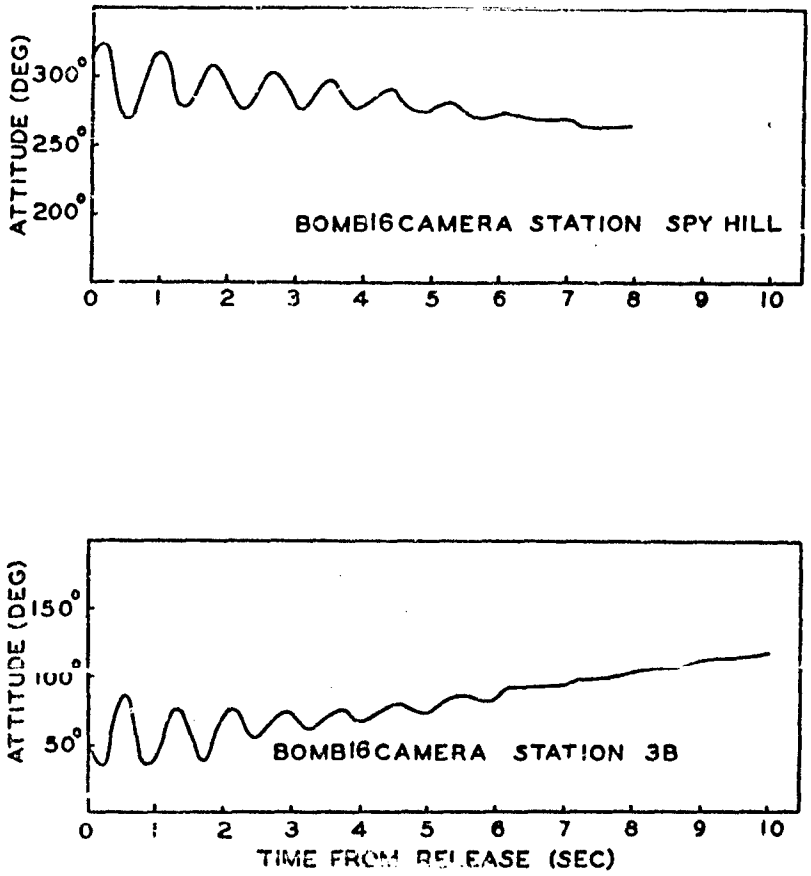

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FIGURE 21

ATTITUDE OF 500 LB BOMB MK 32 RELEASED
AT 520 KNOTS TRUE AIR SPEED

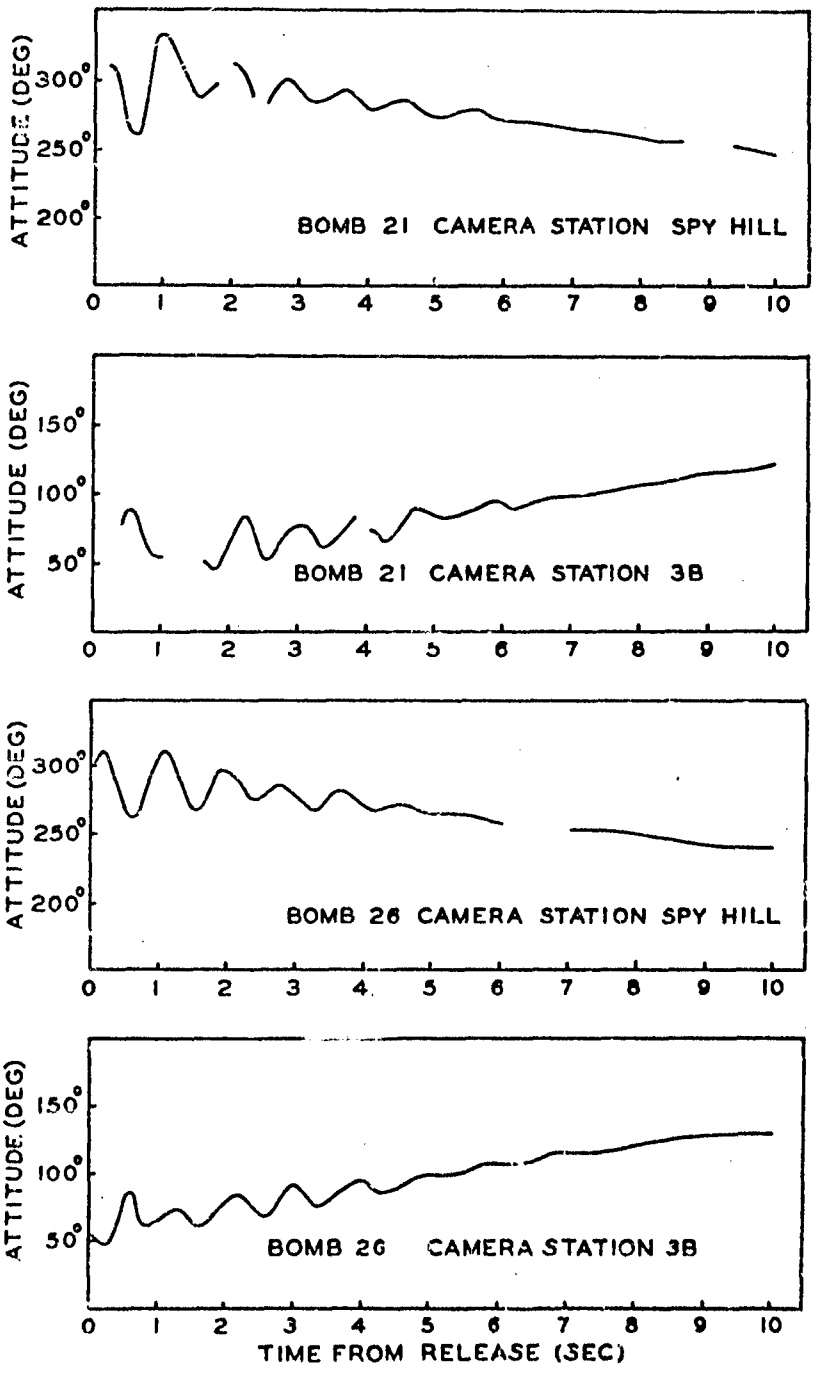

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FIGURE 22

APPENDIX D